Obtaining and analyzing the characteristics curves of a solar cell

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Abstract—The world spend all the capabilities to meet every day demand of energy and it is very expectable that soon we will come up short on any of natural energy source such as petrol, mineral etc… therefore, renewable vitality arrangement has accomplished. Sun powered energy is a standout amongst the most important means of renewable energy resource, more energy is produced by knowing the specification of the cell used and this can be done by getting the IV and PV characteristic curves. The study of a photovoltaic system requires a precise knowledge of the IV and PV characteristic curves, the learning of the curves permits IV and PV characteristic curves allow knowing the function of the cells used. This research shows the results obtained by using solar module analyzer for different power solar cells.

Key words: Photovoltaic cells, PV-IV curves

I. INTRODUCTION

The new challenge is began at the end of second half of the 20th century for finding renewable energy sources because of the limitation of the ordinary energy source (oil, gas, coal etc…) and increasing demand of energy, this why the attention is turning to the renewable energy sources [1-3]. The traditional fossil fuels as coal, oil and natural gas combustion caused many severe problems as global warming, Ozone hole, and the acid rains [4-6]. Renewable energies as the solar, wind, hydraulic, and geothermal energies are clean, abundant, and green. They are environment friendly [7-9]. Solar energy as a renewable and sustainable energy is the most significant alternative for the fossil fuels [10-12]. Photovoltaics are considered as electricity energy source due to its dependence on solar energy which is one of the renewable energy sources [13, 14]. PV modules are sustainable, clean with long service life and high reliability [15]. Photovoltaic cells operate in the external atmosphere and are subject to the environmental and weather variables as wind speed, air temperature, solar intensity and air humidity [16-18]. Producers evaluate photovoltaic units according to standard test conditions [19]. These conditions define the PV module work at solar radiation intensity of 1000 W/m², air temperature 25°C, and relative humidity of 45% [20-23]. In any case, to do an impressive optical construction, the proper imaging of the photoelectric unit of electrical behaviour (V-I bends) is vital [24, 25].

The solar cell characteristics were partitioned into two gatherings, the static parameters and the dynamic parameters [26]. The static parameters are regularly decided from their lit up current-voltage attributes, in view of blaze lights or conveyed light sources, or open air conditions [27]. They are utilized to decide sun oriented cell effectiveness and fill elements (the proportion of greatest possible energy to the result of the open-circuit voltage and short out current) [28]. Then again, dynamic parameters are required in outlining circuits containing sun oriented cells and exchanging gadgets and in addition giving essential indicative instruments [29].

1-1. Solar Cell Characteristics:

A perfect sun oriented cell, hypothetically can be modelled as a current source in parallel with a diode (Fig. 1), direct current generated varies linearly with solar radiation when the solar cell exposed to light [30]. A change of the model incorporates the impacts of a series resistor which represent internal resistance of the cell [31]. The condition describing the relationship between voltage (V) and current (I) gave by a module is as per the following:

\[ I = I_{ph} - I_D \]  \hspace{1cm} (1)

1.2. Ideal Cell

![Fig. 1 Equivalent circuit of a photovoltaic cell](image)

The net current of the cell is equivalent to the distinction of the photocurrent \( I_{ph} \), (the current created by the occurrence light, specifically corresponding to the sun illumination), \( I_D \) (the typical diode current). If each term is replaced by its value is obtained:

\[ I = I_{ph} - I_D \left[ \exp \left( \frac{V - I_D}{mK_T} \right) - 1 \right] \]  \hspace{1cm} (2)

Where:

- \( m \) = Idealized factor.
- \( K \) = Boltzmann’s constant.
- \( T \) = Absolute temperature of the cell.
- \( e \) = Electronic charge.
- \( V \) = Cell voltage.
- \( I_o \) = Saturation current, which depend mainly on cell temperature.

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The typical representation of the output characteristic of a photovoltaic device is called characteristic curve, and demonstrates their conduct. The IV curve shows the relationship between the current and voltage as per the level of episode radiation and temperature. Additionally the PV curve shows a similar relationship yet for power and voltage. These curves can be gotten in a few ways. Predominantly, they can be figured from condition (2) or can be acquired tentatively from the photovoltaic cell. The current voltage curve (IV) demonstrates the conceivable mixes of sets of current-voltage of the photovoltaic instrument. Thoughtfully, the curve shows the combination of current and voltage at which the cell can work, if the irradiance and cell temperature could be kept steady. The assessment of the execution of sun-oriented cells and the outline of photovoltaic frameworks must be founded on the electrical attributes, that is, in the current-voltage connections of the cells subjected to different levels of illumination and temperature [32]. Figure 2 show the Characteristic curves of a solar cell, the horizontal axis represents the working cell voltage (V) and the left vertical axis the current (A) while the right vertical axis power (P).

Breaking down the chart, there are a few trademark focuses. The cell will deliver the most extreme force when the resistance between the terminals of the yield circuit is insignificant; this is when there is short out [33]. The working voltage is zero and this esteem is called "Short Circuit Current" (Isc). The maximum voltage is reached in the case that the resistance is infinite and then the current is zero, the circuit is open, that is, there is "Open Circuit Voltage" ( Voc) [34]. Another indicate consider is the greatest of the PV curve, called most power point (MPP), which corresponds to the point on the IV curve, wherein the area of the rectangle shaped by the focuses (V.I) is greatest. This is the area when the module works with greatest effectiveness and produces the extreme yield control. It is the purpose of most extreme power (VMPP, IMPP). The accessible force of a photovoltaic instrument anytime along the curve is the result of current and voltage by then and its units in Watt [35].

This work aims to define the PV characteristics for any PV array using power solar cell. This work is a part of continuous efforts of the Energy and Renewable Energies Technology Centre, University of Technology, Iraq to widespread the lecture of renewable energies usage and its benefits to citizens and society [36-63].

II. EXPERIMENTAL WORK

One can state that, photocurrent relies on upon the irradiation of the place were the test done and at this moment, for a fixed temperature (in this cases it’s about 25°C). The higher the light, the more prominent the current is. Then again, voltage will keep up practically consistent and it will not shift much. In this research IV curves has been measured, we use two different solar cell sizes one with 0.023 m² and the second is 0.43 m². Figure 3 shows the block diagram of the system connected.

The following apparatus has been used:
1. Solar module analyzer (Prova 200 A) as shown in figure 4.
2. Different solar cells size and.
3. PC for data collection and managing.
4. Solar irradiance meter as shown in figure 5.

The circuit wiring diagram connected shown in figure 6 (a and b).
III. RESULTS AND DISCUSSIONS

Solar module analyser display curves for the results obtained from the test are shown in figure (7, 8, and 9). From the curves obtained one can notice that the red curve is for volt, the green one is for the power while the X axis is for current. The results show the Vopen, Ishort, Pmax, Vmaxp, Imaxp and efficiency for the two size solar cells.

The first test is done for small cell with current range scan begin at 50 mA and current range scan end at 1 A, and irradiance is 230 W/m² as shown in figure 7.

The second test was done for small cell with current range scan begin at 400 mA and current range scan end at 2 A, and irradiance is 230 W/m² as Fig. 8 shows.

The third test is done for large cell with current range scan begin at 0mA and current range scan end at 1 A, and irradiance is 1000 W/m² as shown in figure 9.

IV. CONCLUSIONS

There are many components that influence the execution effectiveness of a solar cell, for example, reflection misfortunes, the ghastly qualities of the light source. From the results obtained one can notice the unsmooth of the curves and that because of the reflection light in the lab we done the test and for the light we used cause it focus on some point of the cell so the illumination is not equal and also for the system error and reading accuracy.

REFERENCES


